

# ASTRODATA TELEMETRY EQUIPMENT

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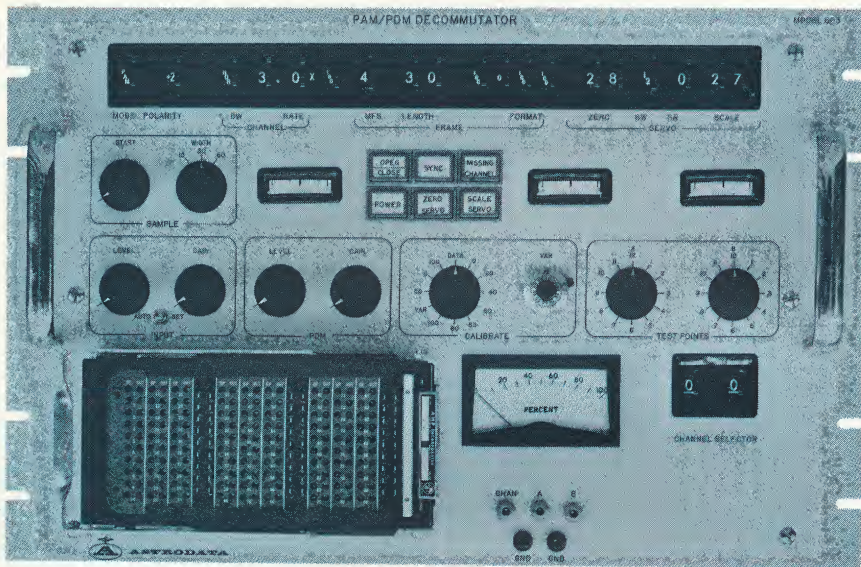
TELEMETRY

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**MODEL 603  
PAM/PDM TELEMETRY  
DECOMMUTATOR**





## Features:

- COMPLETELY AUTOMATIC SET-UP.
- WIDE CAPTURE RANGE:  $\pm 30\%$  FROM PRE-SET CENTER RATE.
- 1 PPS TO 10,000 PPS CHANNEL RATE SELECTION WITHOUT PLUG-INS.
- USE OF PATTERN RECOGNITION FOR FRAME SYNCHRONIZATION.
- UP TO 128 CHANNELS PER FRAME.

### INTRODUCTION

The Model 603 Telemetry Decommutator is an all solid-state system designed for maximum reliability. It is of modular construction, employing plug-in etched circuit cards with edge-mounted incandescent lamp logic state indicators to facilitate maintenance and test. Each etched circuit card also provides edge-mounted test points for monitoring the outputs of every circuit within the system. Certain frequently used test points are wired to front-panel mounted test points through a selector switch.

The Model 603 employs a new unique automatic set-up feature. This AUTO-SET feature will automatically adjust the gain and level of the input amplifier until the signal is within approximately  $\pm 10$  percent of its proper value. This is sufficient for channel and frame synchronization. If the optional zero and full scale servos are included in the system, they may then be energized, and the input adjusted until the Zero and Full Scale deviation meters are centered. The Model 603 is then synchronized, calibrated, and ready for use. The AUTO-SET feature is digitally controlled through the use of counters and digital-to-analog converters to provide an "infinite memory" of the final setting. Once the AUTO-SET cycle has been completed, no further alterations of input gain and level are permitted by the control logic.

1. OFF (channel not used for frame synchronization).
2. 0 (0% data level).
3. 100 (100% data level).
4. MC (missing channel).

The pattern recognition technique makes frame synchronization relatively independent of synchronization pulse amplitude. A frame pattern consisting of 2, 3, or 4 channels can be recognized.

The unit will automatically acquire and track input signals over a range of  $\pm 30\%$  of the selected channel rate.

The unit maintains synchronization with up to 40 consecutive missing pulses at any fixed channel rate within the specified tracking range. Each missing channel illuminates the missing channel indicator.

A front panel thumbwheel switch allows the operator to select 1, 2, 4, or 8 missing frame synchronization patterns to be bypassed before the unit reverts from lock (in sync) to search (out of sync). Lock mode is indicated by illuminating the Sync indicator green, while search condition is indicated by illuminating the Sync indicator red.

Non-accumulative channel jitter of up to  $\pm 10\%$  of the channel period may be accommodated without loss of synchronization.

- in: An internal calibration feature is included with steps of 0, 20, 40, 50, 60, 80, and 100% of full scale. A "VAR" position of the Calibrate switch connects a 10-turn potentiometer with a calibrated dial. Both the Step and Variable calibration voltages are accurate to within  $\pm 0.1\%$  of full scale.

- ion: The use of squid patchcords permits unlimited cross-strapping of supercommutated channels. Optional AMP and MAC type patchpanels are available.

The Model 603 may provide up to 90 parallel decommutated outputs. These outputs are normally analog sample-and-hold storage devices. For certain special applications where no slope-off error or charge-time error can be tolerated, the analog storage device may be replaced by digital-to-analog converters. This replacement requires the addition of an analog-to-digital converter.

Full scale output is 0 to  $\pm 10$  volts at 10 milliamperes from an output impedance of 0.1 ohm for either type of storage device.

The sample-and-hold type output will respond to a 100% change in data within  $\pm 1\%$  of full scale during one channel time. Digital-to-analog converter units are not subject to charge-time errors.

The sample-and-hold storage slope-off rate is dependent upon the front panel selected rate. The table below indicates the slope-off error for the various rate ranges.

| PULSE RATE    | SLOPE-OFF    | DROOP ERROR*<br>PER FRAME |
|---------------|--------------|---------------------------|
| 1-9.9 pps     | 0.1 mv/sec   | 0.03%                     |
| 10-99 pps     | 1.0 mv/sec   | 0.03%                     |
| 100-990 pps   | 10.0 mv/sec  | 0.03%                     |
| 1000-9900 pps | 100.0 mv/sec | 0.03%                     |

\* Droop error assumes the lowest pulse rate of the particular range (1, 10, 100 or 1000 pps) and a 30-channel frame length.

Adjacent channel crosstalk is less than 0.1% of full scale.

Shorting the analog outputs to ground will not damage the circuit.

A large-scale meter and thumbwheel switch in the front panel permit any analog output to be monitored. As an option, a panel containing 30 meters is available to permit simultaneous monitoring of 30 channels. Additional meter panels allow up to 90 channels to be monitored simultaneously.



The system accepts time division multiplex signals with either pulse amplitude modulation (PAM) or pulse duration modulation (PDM). The signal is sampled by an integrate-and-hold technique, and delivered to the output gates, which are controlled by gate pulses on the patchpanel. The Model 603 is normally equipped with thirty output gates; however, the system may be expanded to include up to ninety output gates.

In addition, many optional features are available for the Model 603, including an ASTRODATA Series 3000 Analog-to-Digital Converter as well as a zero and full scale compensation servo system to correct for external drift and scale variations.

A block diagram of the Model 603, which includes the optional compensation system, appears below. The Model 603 Decommutator complies in all respects with the specifications of IRIG Document 106-60, revised.

[illegible]

Accommodates PAM(RZ), NRZ, multiplex formats.

From 1 volt to 20 volts peak-specified 20:1 range.

50% of the peak-to-peak value of the signal.

Greater than 1,000 ohms per v  
less than 50 pf. 10,000 ohm  
available as an option.

Input level and gain are automatic to within  $\pm 10\%$  of the proper level. An AUTO-SET pushbutton is provided. "Gain" potentiometers are mounted on the front panel to allow a fine adjustment.

Synchronization is acquired with an input peak signal-to-ran voltage ratio of 16:1 (24 db) w and noise are bandwidth limit at five times the pulse rate.

When the signal and noise are limited (3 db down) at 10 times the PAM(RZ), NRZ signal-to-noise ratio, the signal-to-noise ratio improves so that synchronization is maintained with a peak signal-to-noise voltage ratio of 10:1 (20 db).

PAM(RZ) peak signal voltage is total excursion from baseline to responding to 100% of PAM. Under specified noise conditions, the receiver may assume any combination of responding all data channels at 0% PAM. 0% PAM data corresponds to the total baseline to 100% data value. NRZ peak signal voltage is total excursion from 0% data value to 100% data value. Proper synchronization is required and maintained with a 24 dB SNR ratio when all adjacent data channels are limited to as little as 1% full scale.

\* In a bandwidth-limited random process, the peak noise equals three times the rms noise value (3 sigma). Peak magnitude is therefore six times the rms noise magnitude.

Synchronization will be acquired with random, symmetrical noise peak amplitude referenced to the peak amplitude of the PDM signal.

Adjustable from 1 pps to 10,000 pps  
by front panel thumbwheel switch

100 pps to 1,000 pps is standard rates from 10 pps to 10,000 pps on special order.

Practically no rise time limitat  
603 will meet all performanc  
when processing filtered pulse  
as low as 1 pps PAM or NRZ  
filtered through a 6-cps (3 db  
— IRIG Subcarrier #1. (10% to  
as slow as 60 milliseconds 3-  
phase low-pass filter. 3-db poi

Accommodates PAM signals with  
of from 40% to 90%.

Sampling of PAM and NRZ delayed over the range from 0 to 100% of the period of the channel period from the start of the pulse. The sample period is 15, 30, or 60% of the channel period. The controls are on the front panel.

The unit can decommutate signals from 128 channels per frame. Frequencies are selected by front panel thumbwheel switches.

The decommutator uses pattern frame synchronization. The pattern selected by front panel thumbwheel switches is used for the last four channels of each frame. There are four positions for each channel, as follows:



## SPECIFICATIONS

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Input Signal Characteristics:</b>             | Accommodates PAM(RZ), NRZ, or PDM time multiplex formats.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Input Level:</b>                              | From 1 volt to 20 volts peak-to-peak, or any specified 20:1 range.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Input DC Offset:</b>                          | 50% of the peak-to-peak value of the input signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Input Impedance:</b>                          | Greater than 1,000 ohms per volt shunted by less than 50 pf. 10,000 ohms per volt is available as an option.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Input Gain and Level Adjustments:</b>         | Input level and gain are automatically adjusted to within $\pm 10\%$ of the proper value when the AUTO-SET pushbutton is pressed. "Level" and "Gain" potentiometers are mounted on the front panel to allow a fine adjustment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Signal-to-Noise Performance<br/>PAM, NRZ:</b> | <p>Synchronization is acquired and maintained with an input peak signal-to-random rms noise* voltage ratio of 16:1 (24 db) where the signal and noise are bandwidth limited (3 db down) at five times the pulse rate.</p> <p>When the signal and noise are bandwidth limited (3 db down) at 10 times the pulse rate, the PAM(RZ), NRZ signal-to-noise performance improves so that synchronization is acquired and maintained with a peak signal-to-rms noise voltage ratio of 10:1 (20 db).</p> <p>PAM(RZ) peak signal voltage is defined as the total excursion from baseline to a voltage corresponding to 100% of PAM data. Under the specified noise conditions, the data channels may assume any combination of values including all data channels at 0% PAM data where 0% PAM data corresponds to 20% of the total baseline to 100% data value deviation.</p> <p>NRZ peak signal voltage is defined as the excursion from 0% data value to 100% data value. Proper synchronization will be acquired and maintained with a 24 db signal-to-noise ratio when all adjacent data channel excursions are limited to as little as 20% of full scale.</p> <p>* In a bandwidth-limited random distribution, peak noise equals three times the symmetrical rms noise value (3 sigma). Peak-to-peak noise magnitude is therefore six times the rms noise magnitude.</p> |
| <b>PDM:</b>                                      | Synchronization will be acquired and maintained with random, symmetrical noise up to 48% peak amplitude referenced to the peak amplitude of the PDM signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Commutation Rate<br/>PAM, NRZ:</b>            | Adjustable from 1 pps to 10,000 pps, selected by front panel thumbwheel switches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>PDM:</b>                                      | 100 pps to 1,000 pps is standard. Non-standard rates from 10 pps to 10,000 pps are available on special order.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Rise Time:</b>                                | Practically no rise time limitations. The Model 603 will meet all performance specifications when processing filtered pulse trains at rates as low as 1 pps PAM or NRZ that have been filtered through a 6-cps (3 db) low-pass filter — IRIG Subcarrier #1. (10% to 90% rise time as slow as 60 milliseconds 3- or 5-pole linear phase low-pass filter, 3-db point at 6 cps.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Duty Cycle:</b>                               | Accommodates PAM signals with a duty cycle of from 40% to 90%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Sample Controls:</b>                          | Sampling of PAM and NRZ pulses can be delayed over the range from 0% to 60% of the channel period from the beginning of the pulse. The sample period can be set at 15, 30, or 60% of the channel period. Both controls are on the front panel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Frame Length:</b>                             | The unit can decommutate signals with up to 128 channels per frame. Frame length is selected by front panel thumbwheel switches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Frame Synchronization:</b>                    | The decommutator uses pattern recognition for frame synchronization. The pattern format is selected by front panel thumbwheel switches for the last four channels of the commutator frame. There are four positions available for each channel, as follows:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

1. OFF (channel not used for frame synchronization).
2. 0 (0% data level).
3. 100 (100% data level).
4. MC (missing channel).

The pattern recognition technique makes frame synchronization relatively independent of synchronization pulse amplitude. A frame pattern consisting of 2, 3, or 4 channels can be recognized.

**Tracking:** The unit will automatically acquire and track input signals over a range of  $\pm 30\%$  of the selected channel rate.

**Missing Channels:** The unit maintains synchronization with up to 40 consecutive missing pulses at any fixed channel rate within the specified tracking range. Each missing channel illuminates the missing channel indicator.

**Missing Frame Synchronization Patterns:**

A front panel thumbwheel switch allows the operator to select 1, 2, 4, or 8 missing frame synchronization patterns to be bypassed before the unit reverts from lock (in sync) to search (out of sync). Lock mode is indicated by illuminating the Sync indicator green, while search condition is indicated by illuminating the Sync indicator red.

**Channel Jitter:** Non-accumulative channel jitter of up to  $\pm 10\%$  of the channel period may be accommodated without loss of synchronization.

**Internal Calibration:** An internal calibration feature is included with steps of 0, 20, 40, 50, 60, 80, and 100% of full scale. A "VAR" position of the Calibrate switch connects a 10-turn potentiometer with a calibrated dial. Both the Step and Variable calibration voltages are accurate to within  $\pm 0.1\%$  of full scale.

**Superdecommutation:** The use of squid patchcords permits unlimited cross-strapping of supercommutated channels.

**Patchpanel:** Optional AMP and MAC type patchpanels are available.

**Analog Outputs:** The Model 603 may provide up to 90 parallel decommutated outputs. These outputs are normally analog sample-and-hold storage devices. For certain special applications where no slope-off error or charge-time error can be tolerated, the analog storage device may be replaced by digital-to-analog converters. This replacement requires the addition of an analog-to-digital converter.

Full scale output is 0 to +10 volts at 10 milliamperes from an output impedance of 0.1 ohm for either type of storage device.

**Charge Time:** The sample-and-hold type output will respond to a 100% change in data within  $\pm 1\%$  of full scale during one channel time. Digital-to-analog converter units are not subject to charge-time errors.

**Slope-Off:** The sample-and-hold storage slope-off rate is dependent upon the front panel selected rate. The table below indicates the slope-off error for the various rate ranges.

| PULSE RATE    | SLOPE-OFF    | DROP ERROR* |
|---------------|--------------|-------------|
|               |              | PER FRAME   |
| 1-9.9 pps     | 0.1 mv/sec   | 0.03%       |
| 10-99 pps     | 1.0 mv/sec   | 0.03%       |
| 100-990 pps   | 10.0 mv/sec  | 0.03%       |
| 1000-9900 pps | 100.0 mv/sec | 0.03%       |

\* Droop error assumes the lowest pulse rate of the particular range (1, 10, 100 or 1000 pps) and a 30-channel frame length.

**Crosstalk:** Adjacent channel crosstalk is less than 0.1% of full scale.

**Short-Circuit Protection:** Shorting the analog outputs to ground will not damage the circuit.

**Meter Display:** A large-scale meter and thumbwheel switch in the front panel permit any analog output to be monitored. As an option, a panel containing 30 meters is available to permit simultaneous monitoring of 30 channels. Additional meter panels allow up to 90 channels to be monitored simultaneously.



# Optional Zero and Full Scale Compensation System:

A highly versatile data compensation system is offered for the Model 603 Telemetry De-commutator. Any channel may be programmed by thumbwheel switches on the front panel to serve as a zero or full-scale reference. A four-position compensation servo "slewing rate" (SR) thumbwheel selector defines the maximum compensation correction to be compensated per frame (1, 2, 5, or 10% of full scale).

Another four-position compensation servo "bandwidth" (BW) thumbwheel selector establishes what percentage (12.5, 25, 50, or 100%) of the SR defined maximum correction will be performed per frame. With this ability to control conveniently the compensation servo slewing rate and loop bandwidth, the operator can optimally tailor the servo loop characteristics for any signal situation.

Arbitrary reference channel magnitudes may be accommodated from 0 to +20% (zero reference) and 80 to 100% (full scale reference). Factory adjustments assume that zero reference channel is 0% of data and full scale reference is 100% of data.

Total dynamic range of the compensation servo is  $\pm 20\%$  from nominal. Total data error, when operating in the servo compensated mode, does not exceed  $\pm 0.25\%$  of full scale. When adjusted for fastest response (SR set at 10% and BW set at 100%), the system will compensate within one channel interval for 100% of the observed change in reference value up to a maximum change equal to 10% of full scale. Detected reference changes greater than 10% of full scale are regarded as 10% changes.

Compensation servos are automatically held at the last valid value during loss of synchronization conditions.

## External Scope Synchronization:

Patchpanel provisions allow regenerated frame sync or any signal appearing on the patchpanel to serve as sweep trigger for an external oscilloscope.

## Optional Displays:

Optional large-screen bargraphs and oscilloscopes are available on special order.

## Optional A-D Converter:

Optional ASTRODATA Series 3000 Analog-to-Digital Converter is available to provide digital data output for DAC's and digital recorders.

## Controls and Indicators

- Mode:** Thumbwheel switch to select PAM, PDM, or NRZ mode of operation.
- Polarity:** Thumbwheel switch to select either positive or negative excursion of signal pulses, and either data or simulator inputs.
- RBW:** Thumbwheel switch to select the loop bandwidth of the channel rate phase-locked-loop.
- Rate:** Three thumbwheel switches to select the nominal pulse rate of the input signal.
- MFS:** Thumbwheel switch to select the number of missing frame synchronization patterns to be ignored before reverting to the search mode.
- Length:** Three thumbwheel switches to select any frame from 1 to 128 channels.
- Format:** Four thumbwheel switches to select the frame synchronization pulse pattern.
- Zero:** Three thumbwheel switches to select the zero reference channel.
- BW:** Thumbwheel switch to select the loop bandwidth of the zero and full scale compensation servo system.
- SR:** Thumbwheel switch to select the slewing rate of the zero and full-scale compensation system.
- Scale:** Three thumbwheel switches to select the full-scale reference channel.

NOTE: Zero, BW, SR, and Scale controls apply only to decommutators equipped with the optional zero and full-scale compensation servos.

- Sample Start:** Multi-turn potentiometer to adjust the intra-channel start time of the data integrator. Adjustable from 0% to 60% of channel interval.
- Sample Width:** Three-position rotary switch to select a data integration period of 15, 30, or 60% of the channel period.
- Rate Deviation Meter:** Zero-center meter to indicate pulse rate deviation of the input signal.
- Open/Closed:** Pushbutton switch to allow the operator to open the channel synchronization loop. The loop remains open as long as the pushbutton is held depressed.
- Sync Indicator:** Lamp to indicate synchronization status. An "in sync" condition is indicated when the lamp is green, and an "out of sync" condition is indicated when the lamp is red. A corresponding logic-level signal is available on a rear panel connector.
- Missing Channel Indicator:** Lamp to indicate missing channel pulses. The lamp glows red when missing channels are detected.
- Power:** Power On/Off control.
- Zero Servo:** Illuminated pushbutton control to activate or deactivate the zero compensation servo.
- Scale Servo:** Illuminated pushbutton control to activate or deactivate the full-scale compensation servo.  
NOTE: The scale servo switch is interlocked with the zero servo switch to prevent operation of the scale servo without the zero servo.
- Zero Deviation Meter:** Zero-center meter to indicate variations of the zero reference channel.
- Scale Deviation Meter:** Zero-center meter to indicate variations of full scale reference channel.
- Auto-Set:** Pushbutton to initiate the automatic level and gain controls.
- Input Level:** Multi-turn potentiometer for fine adjustment of the input dc level after the Auto-Set operation is completed.
- Input Gain:** Multi-turn potentiometer for fine adjustment of the input amplitude after the Auto-Set operation is completed.
- PDM Level:** Multi-turn potentiometer for fine adjustment in the PDM mode of the output signal dc level from the PDM-to-PAM converter.
- PDM Gain:** Multi-turn potentiometer for fine adjustment in the PDM mode of the output signal amplitude from the PDM-to-PAM converter.
- Calibrate:** Multi-position rotary switch that provides seven calibrated voltages equal to 0, 20, 40, 50, 60, 80, and 100% of full scale for calibration of output recorders.
- VAR:** Ten-turn potentiometer with a calibrated dial to set the calibration voltage when the calibrate switch is set to VAR.
- Test Points:** Two 12-position rotary switches to select test signals from within the decommutator to be routed to two test points on the front panel, and two BNC connectors on the rear panel.
- Percent Meter:** Wide-scale meter to indicate the level of the selected analog output.
- Channel Switch:** Two thumbwheel switches to select the analog output to be monitored by the Percent meter.
- Test Points** Five test points are provided on the front panel:
  1. Channel: Monitors the voltage of the analog output selected by the Channel thumbwheel switches.
  2. A: Monitors the signal selected by the "Test Points A" switch.
  3. B: Monitors the signal selected by the "Test Points B" switch.
  4. Ground.
  5. Ground.
- Power Requirements** 115 VAC  $\pm 5\%$ , single phase, 50-400 cps, 500 watts.
- Physical Dimensions** 12.25-in. high x 19-in. wide x 19-in. deep.



**ASTRODATA INC.**

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☐ Please add my name to your mailing list ☐ Please have representative call

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